Watershed Detectives: The Fish Kill Mystery

LESSON 3
Finding the Pollution Source

Overview
In this lesson, students gather evidence to investigate the nature of the creek contamination in and around Country Club Creek by testing soil and water from various test sites. Students are presented with a map of Country Club Creek containing 35 possible test sites and must use information from the Country Club Creek Fish Kill Lab Report and clues from previous activities to decide where to sample sites. Students discuss the source of contamination, difficulties in determining the exact pollutant concentrations, and the uncertainties that arise from making conclusions with limited data. This discussion leads to questions about the timing and extent of clean up procedures.

TEKS (7th Grade Science)
7.1A-B, 7.2 A-C & E, 7.4A, 7.8C

Time
One class period

Purpose
The students will:
1. Work with other students to plan, research and analyze data.
2. Understand that research plans must consider limits in technical and economic resources.
3. Revise working hypothesis in light of new information.
4. Use a simulated testing procedure to determine the pollutant concentration of the water samples.
5. Discuss limits in accuracy in data collection and analysis.
6. Discuss the impact of uncertainty in interpreting test results and subsequent decision-making.

Materials
For each student:

- ☐ Completed student worksheet 1.3-Watershed Analysis Lab
- ☐ Student worksheet 3.2-What is your Testing Plan?
- ☐ 1979 newspaper article (to be passed out at end of lesson)
- ☐ Student Sheet 3.3-Mabel Davis Now (can be given as homework)

For each group of 4-6 students:

- ☐ chemplate
- ☐ paper towels or sponge, as needed
- ☐ Student sheet 3.1-Test sites

For the teacher:

☐ 35 site samples in dropping bottles

☐ 4-6 dropping bottles of universal indicator solution

Documents for document camera or overhead projector:

☐ Student sheet 3.1-Test sites

☐ Student sheet 3.2-What is your testing plan?

☐ Map Key: Concentration Levels of Sample Sites

Getting Ready

Arrange the site bottles in areas of the room for easy student access. Put a bottle of universal indicator with each group of samples. Arrange for the distribution of chemplates and paper towels to each group of students. Duplicate copies of student sheets 3.1 for each group and 3.2 for each student. Make sure all students have their completed student sheet 1.3 available.

THE ACTIVITY

1. Introduction

☛ Display overhead of map of test sites and pass the map out to each student group.

Inform the students that now that they have discovered the pollution type, they must further investigate to discover where it is coming from. Remind the students that the pond in Mabel Davis Park where the fish kill occurred is **fed by surface water runoff and a groundwater spring**.

2. Brainstorm before testing

Ask students:

☛ What type of samples would you collect? (surface water, soil, groundwater)

Inform the students they will be drilling test sites to survey the soil and water for pesticide contamination. After the discussion from Lessons 1 and 2, they should have some idea about where the sources of pesticide could have come from. Sites north of the park are all wells.

☛ Tell students they do not know the flowpath of groundwater, only the surface water.

TEACHER NOTE: The sediment test will not look like an actual sediment sample. Sediment is added to water before it is tested for specific contaminants, so that is why it is in liquid form.

☛ Tell students that each group has $1,500 to spend for the project, and it costs $300 to drill a well to test ground water, $200 to test soil, and $100 to test water (the true cost of lab analysis in 2000). Therefore, each group can test any number of sites, as long as they don’t exceed $1500. They must test at least one of each type of sample (groundwater, soil, water). Although groups will be limited to the amount of sites they test, after all the groups have tested, they will share their data with the other groups. During a typical environmental investigations, several different agencies (city, state-Texas Commission on Environmental Quality, federal-USGS, health department) will get involved to test different areas and compare data.

☛ Announce that the sites must be tested one at a time to minimize unnecessary student traffic in the room.   You should have already set up the two sets of samples in different parts of the room so that students will not congregate in one part of the room.   Remind students to put the bottles back as soon as they are done using them so others students can use them.

☛ Display Part 1 student sheet transparency. Tell students to first decide as a group which sites they plan to test, reminding them that they have $1500 for the project. Handout student sheet 3.2 and have them fill out Part 1.

3. Pesticides and parts per billion

☛ Display Part 2 student sheet transparency.

TEACHER NOTE:
Remind the class that the tests furnish information on pesticide concentrations expressed as parts per billion (ppb) or µg/l (micrograms per liter); 1 ppb is one liter of pesticide per billion liters of water. Monitoring stations in Austin can detect pollutants in water bodies in measurements of parts per million (ppm), parts per billion (ppb), and even per trillion. ppm is also equivalent to mg/l; ppb=µg/l

Explain that health officials have decided that an allowable level of pesticide in water is 3.0 ppb. Some students may disagree, suggesting that they would not drink water containing any pesticide. For them, 0 ppb is the only safe level. You may wish to respond that it is impossible to remove all the pesticide. Even to reduce it to extremely small levels, say 1 ppb or less, is extremely time consuming and costly. The important decision health officials have to make concerns the level at which the pesticide is harmful to our health.   Environmental regulators set the standard for aquatic life at 0.0002 ppb (lower because the organisms are smaller).

4. Demonstrate Test Procedures

☛ Demonstrate the test procedure on the overhead projector, using a transparent chemplate.

The following procedure is suggested for demonstrating the site testing:

1. Choose site #21 (a site where Pesticide was not detected). Do not disclose the site number to the class.

2. Squeeze 4 drops of the site solution into one of the cups in a Chemplate. Add 2 drops of indicator to the cup.

3. Ask students to describe the color of the solution in each cup, comparing it to the chart on Student Sheet 3.2-Part 2.

4. Note that the chart correlates color with the level of pesticide contamination and the corresponding code numbers. For example, purple indicates a pesticide concentration of more than 32 ppb which is a code 4. If they detect a code 4, they have found the source of the pollution.

5. Ask the class whether ND (not detected) means that there is no pesticide in the water or whether other explanations might exist. Summarize their comments on the chalkboard. From the discussion, it will be obvious that ND might have many meanings, including a low level of pesticide in the water, none at all, or possibly an error in testing. Errors in testing may be positive

or negative and can arise from taking a sample at the wrong place at the wrong depth; mislabeling the samples in the field or lab; or having problems with the test itself, such as chemical changes in the pesticide as it sits on the shelf waiting to be tested.

6. Tell students to record their results on student sheet 3.2 Part 2 as they test their sites. They should continue testing even if they find a Code 4 (tell them more than one site could be Code 4). If they do find a Code 4, tell students not to tell the other students in the class until everyone has completed the tests.

7. Remind the class that they are only testing for pesticides.

☛ Point out that groups may choose to change their strategy as they obtain information from various site tests. Making these kinds of decisions is not an easy task. Many actual research groups spend long periods of time studying the problem to determine just what strategy to use. This is one of a number of reasons why clean up is not likely to commence as soon as contamination is detected in an area. Deciding on the extent of the contamination and how to effectively clean it up is frequently as complex as the clean up itself, if not more so.

SAFETY NOTE:
The liquids in the bottles are not solutions of pesticide but are nontoxic substances that simulate the pesticide.

☛ Ask the students why a real pesticide is not included in the module. Some may mention cost and convenience. These factors are considered; however, the sites contain nontoxic substance for safety reasons. A pesticide represents a health risk and requires special handling procedures. In this activity, the universal indicator test is used as an alternative to actual testing procedures requiring very specialized equipment and technically trained individuals.

5. Clean up

The last tester from each group has the responsibility to rinse out the Chemplate. Distribute paper towels or rags to clean out the Chemplate. Distribute the towels to clean up any spills at the tables. Collect Chemplates for later use.

6. Wrapping up

☛ Have students answer the questions at the end of the lab sheet. Discuss their responses to the questions while filling out Student Sheet 3.2 overhead transparency.

1. Which site most likely caused the fish kill?
- the baseball field

☛ Present the **Map key: Concentration levels of Sample Sites** overhead transparency to the class. Circle the sites with concentration codes of 2-4.

2. Why do you think high concentrations were found at some of the other sites not associated with the fish kill?

- pesticides may have been used on the farm or lawns (houses and IRS buildings)

3. Did you see any trends in your results-how was the pesticide dispersed?
- levels decreased from park pond towards the Colorado River

4. What could be the source of such high levels of pesticide at the “SOURCE” site (Code 4)?
- answers may vary- the problem was buried bags of pesticides (students will read the article later)

5. How would you proceed with this investigation?
- Continue testing around the baseball field and creek to determine the extent of the contamination in order to excavate the area that is most highly contaminated-point out that if more sites are tested, they must also consider the costs involved. How much more information would be obtained by testing 10 sites, 15 sites, or by filling in the entire area with test sites? and what would it cost? some degree of uncertainty still exists because errors in sampling and testing are possible. Also because you can’t test every single spot, you have to make assumptions about the concentration of contaminants between sampling points. Depending on the distance there can be a high degree of variability in concentrations. Scientists and other decision-makers require sufficient evidence to make an informed decision. They must balance this need for evidence with a consideration of the resources (money, time, materials) it would take to obtain the evidence. Drilling wells every 10 meters would certainly give a more accurate picture of the problem (and be more statistically significant), but it would be prohibitively expensive.

6. Who in the community might be concerned about high levels (Code 2-4) of pesticides? Why?
- residents living at or near the farms-if the wells were used for drinking water, they would be tested on a regular basis and they would already have this information.
- downstream residents.
- parents of children playing in the park.
- citizens using the park or fishing/playing in the pond.
- Health department and Parks Department.

Why?
- some of the levels are way above the safe level for human health.

How does the uncertainty of the extent of the contamination affect clean up decisions? The contamination currently does not threaten the Colorado River, Austin’s water supply. However, if it were to rain for a long period of time, more of the pesticide could begin to move downstream toward the Colorado River.

☛ Get the students to consider strategies for deciding on a course of action based on evidence (data) that may have associated uncertainty. Ask them whether their assessment of the danger to the water supply would change if they assumed a large margin for error instead of a small margin for error in each well test.

Students usually align themselves into two groups in the discussion. One group argues for no compromise to human safety (“no risk”), regardless of clean up expense. Another group argues that problems of limited resources must be taken into account. There are good arguments for both sides. Certainly no one wants to compromise human safety and welfare. However, many environmental health problems exist, and the resources available to solve these problems are finite. Therefore, a compromise decision is generally reached in which safety and resources are taken into account.

☛ It is important to help the students realize that this decision is not a completely scientific one. Two communities with exactly the same problem may make different decisions because of factors, such as available resources and other clean up problems. Science can make the measurements and provide the evidence. The decision regarding the use of the evidence and what clean up action to take is a political one, although one hopes that it is based on the evidence provided by science (and not the newspaper!).

7. Reading Assignment:

☛ Hand-out the newspaper article about the actual event or display a transparency of the article. Discuss the article with the class pointing out that 1) the pesticides were dumped by the landfill, 2) DDT, Toxaphene and lindane were found, and 3) the pesticides will be disposed of according to federal regulations.

If there is not enough time for students to read the article in class, have them read it for homework.

Finish the module with student sheet 3.3 Mabel Davis Now. The assignment instructs students to find out more about the events occurring at Mabel Davis Park in 2000 (this can be completed as homework).

Sample Site Concentrations

Site #	Location	Concentration (ppb)	Sample type	COST ($)
1	Farm		well	300
2	RR tracks		soil	200
3	RR tracks		soil	200
4	Land		soil	200
5	RR tracks		soil	200
6	Gas station		well	300
7	Storage		soil	200
8	Storage		soil	200
9	Gas station		well	300
10	Landfill		well	300
11	Gas station		well	300
12	Ben White		water	100
13	Trib		water	100
14	Trib		water	100
15	Trib		water	100
16	Houses/park		soil	200
17	Houses		well	300
19	Newell pond		water	100
20	Farm		well	300
21	School		well	300
22	I-35		well	300
23	Landfill		well	300
24	Apts		well	300
25	Treasury		well	300
26	Barrow Estates		soil	200
27	IRS		soil	200
28	Land		soil	200
29	Park		soil	200
30	S of pond		well	300
31	Baseball field		soil	200
32	Landfill		well	300
33	Trib		water	100
34	Trib		water	100
35	Trib		water	100

KEY-Sample Site Concentrations

Site #	Location	Concentration (ppb)	Sample type	COST ($)
1	Farm	3	well	300
2	RR tracks	1	soil	200
3	RR tracks	1	soil	200
4	Land	1	soil	200
5	RR tracks	0	soil	200
6	Gas station	0	well	300
7	Storage	0	soil	200
8	Storage	0	soil	200
9	Gas station	0	well	300
10	Landfill	0	well	300
11	Gas station	0	well	300
12	Ben White	0	water	100
13	Trib	1	water	100
14	Trib	1	water	100
15	Trib	1	water	100
16	Houses/park	2	soil	200
17	Houses	2	well	300
19	Newell pond	1	water	100
20	Farm	3	well	300
21	School	0	well	300
22	I-35	0	well	300
23	Landfill	0	well	300
24	Apts	0	well	300
25	Treasury	1	well	300
26	Barrow Estates	3	soil	200
27	IRS	1	soil	200
28	Land	1	soil	200
29	Park	0	soil	200
30	S of pond	2	well	300
31	Baseball field	4	soil	200
32	Landfill	1	well	300
33	Trib	3	water	100
34	Trib	3	water	100
35	Trib	2	water	100